IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	DEVELOPMENT OF FLEXIBLE REFORMER-BASED FUEL CELL TECHNOLOGY FOR SMALL-SCALE POWER GENERATION	
Project Number	**IMURA0646** *(will be inserted by The Academy)*	
Monash Main Supervisor (Name, Email Id, Phone)	Prof. Akshat Tanksale, Akshat.Tanksale@monash.edu	*Full name, Email*
Monash Co-supervisor(s) (Name, Email Id, Phone)		
Monash Department:	Department of Chemical Engineering	
Monash ADRT (Name,Email)		*Full name, email*
IITB Main Supervisor (Name, Email Id, Phone)	Prof. S. Srinivas, s.srinivas@iitb.ac.in,	*Full name, Email*
IITB Co-supervisor(s) (Name, Email Id, Phone)	Prof. Prakash C. Ghosh, pcghosh@iitb.ac.in, Prof. Manaswita Bose, manaswita.bose@iitb.ac.in,	
IITB Department:	Department of Energy Science & Engineering	

Research Academy Themes:

Highlight which of the Academy's Theme(s) this project will address?
(*Feel free to nominate more than one. For more information, see www.iitbmonash.org)*

1. **Advanced computational engineering, simulation and manufacture**
2. Infrastructure Engineering
3. **Clean Energy**
4. Water
5. Nanotechnology
6. Biotechnology and Stem Cell Research
7. Humanities and Social Sciences

The research problem

Power generation on a small-scale (few kW to 1 MW) is commonly accomplished by the use of diesel generator (DG) sets. An alternative for such portable power generation is based on reformer-based fuel cell technology. Though reforming is a well-known technology, it is conventionally operated on a large scale and typically using methane (natural gas) as the feed. Since availability and accessibility to gas is problematic on a smaller scale, a better option is to use liquids like methanol, ethanol, gasoline and diesel as the reformer feed. This offers challenges in the design and/or selection of appropriate catalyst for reforming, selection and design of the reactor for reforming, integrating the different system components like the reformer, the shift reactor, the clean-up process, the fuel cell stack, and other utilities. While Ni-based catalysts are most commonly used for steam methane reforming, they have a

problem with coking. This problem can be expected to be higher with the use of feeds like gasoline and diesel – hence, appropriate catalyst modifications might be necessary. Since a small-scale reformer is needed, it is necessary to look at novel reactor designs like micro-reactors, auto-thermal reactors, etc. and choose the promising option among one of these. In terms of system integration, challenges are foreseen in the choice of individual sub-systems and their performance. For example, conventional reformers operate at a fairly high pressure to lower the size of the downstream processing equipment and hence, the capital cost. However, for a portable power generation unit, it may be expensive to have a syngas compressor. Likewise, the performance of the shift reactors and other separation processes based on adsorption is good at higher pressures. So, a trade-off is expected in terms of performance vis-à-vis cost. The problem, thus, encompasses looking at both the technical and economic aspects of the proposed portable power generation alternative.

Project aims

The following are the aims of the project:

1. Literature survey on catalysts used for reforming of methanol, ethanol, gasoline and diesel, and selection of appropriate catalyst(s).
2. Literature survey on micro-reactors and auto-thermal reactors used for reforming at small-scale, and identifying the appropriate type.
3. CFD Study to simulate the performance of the multi fuel reformer setup before actual experimentation.
4. Experiments with the chosen catalyst and reactor configuration to generate kinetic data, check conversion and catalyst deactivation, identify promoters or catalyst modifications, if necessary and repeat the experiments with the new modified catalysts.
5. Market survey of available technologies for the other sub-systems in the process like compressor, shift reactor, clean-up system, fuel cell stack, etc. and developing cost models for them, wherever necessary.
6. Performing process simulation to identify process integration opportunities and to help in equipment sizing and design.
7. Techno-economic feasibility study based on the simulation tool developed.

Expected outcomes

1. Appropriate catalyst(s) and reactor configuration for a reformer that is flexible enough to handle different kinds of feeds.
2. A proto-type of the portable generation unit having all the components.
3. A simulation tool that can be used to evaluate the performance of the plant under different conditions.

How will the project address the Goals of the above Themes?

The CFD and the techno-economic feasibility analysis parts of the project will help to develop tools for the evaluation of the proposed technology.

Capabilities and Degrees Required

The minimum educational qualifications are:
Master's degree in Chemical Engineering/Technology; or
Bachelor's degree in Chemical Engineering/Technology and a valid GATE score;

NOTE: Candidates without a valid GATE score or research fellowship can be considered for admission if they have a minimum of two years of professional experience. Competition for places is high and a competitive selection process is applied to all applicants.

Potential Collaborators

Please visit the IITB website www.iitb.ac.in OR Monash Website www.monash.edu to highlight some potential collaborators that would be best suited for the area of research you are intending to float.

Please provide a few key words relating to this project to make it easier for the students to apply.

Reforming; Catalysts; Fuel Cells; CFD; Process Simulation; Feasibility study; Reaction Engineering